

NOTES ON CYTHEREA (TIVELA) CRASSATELLOIDES CONRAD, WITH DESCRIPTIONS OF MANY VARIETIES.

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The quahog or hard-shell clam, *Venus mercenaria*, of the Atlantic coast of the United States is probably the largest, most solid and heavy of any of the species of the *Veneridae*. The southern form, known as variety *mortoni* Conrad, frequently attains the weight of between three and four pounds, exclusive of the soft parts. Many specimens of these solid fellows were collected in Tampa Bay in January to March, 1869, by Colonel Jewett, Dr. Stimpson, and myself.

The next representative of the *Veneridae* in the matters of size and weight is *Tivela crassatelloides*, of the west coast. The geographical range of this latter species extends from Ballenas Bay, Lower California (*Albatross*), N. latitude $26^{\circ} 45'$, northerly to Santa Cruz in California proper, as reported. It is abundant in Moro Bay, north of Point Concepcion, and common at Santa Monica and Long Beach in Los Angeles County, on the outer shore of the Coronado peninsula, San Diego, and at many other localities between the limits first indicated. It is at the present time the commonest clam in the Los Angeles markets, which are supplied principally from Santa Monica and Long Beach. It frequently measures 6 inches in length (anterior to posterior margins), and reaches a weight of nearly 2 pounds. As an article of food I regard it as the best of the so-called clams that are found along this part of the coast. Its favorite station is at the lowest tide marks, and it seems to prefer a clean sand to sandy mud or muddy sand between ordinary tide marks, where the other principal clams of the Los Angeles markets are found, namely, *Tapes diversa*, *Chione simillima*, and *C. succincta*.

Tivela crassatelloides was described by Conrad¹ as *Trigona crassatelloides*. It is the *Pachydesma* of Carpenter's British Association report and, until recently, of California authors.

In Reeve's *Conch. Iconica*,² *Cytherea crassatelloides*, it is described, probably quoting Conrad, as follows:

Shell obliquely ovate, rather oblong, moderately triangular, thick, heavy, ventricose, covered with a thick horny epidermis, cream color, rayed with purple-violet.

¹ Jour. Acad. Nat. His. Sci. Phila., 1837, VII, p. 253, pl. XIX, fig. 17.

² Volume XIV, 1864, pl. 1.

For a species so numerous in individuals it is quite uniform in outline, though examples are occasionally met with that are decidedly triangular, and infrequently an extremely elongated specimen occurs—not one in a hundred.

The more ventricose individuals are only moderately tumid. The epidermis in large adults is notably thick and deciduous, soon contracts and peels off, even after a good oiling or treatment with glycerine, and the colors are fugitive.

The color of the rays as given in the foregoing description, "purple-violet," suggests that the specimen upon which the description is based was more or less denuded, for when the epidermis is intact the rays can hardly be called purple-violet, although it is possible that such an example may sometimes occur. In half-grown examples or individuals under that size the epidermis is more tenacious or adherent; in these, however, a slight rubbing with sweet oil or glycerine is a wise precaution.

Conrad's description, as will be seen by what follows, is altogether too brief and fails to give any idea of the range of color that is exhibited by this species where a large number from different localities are brought together. The general or ground color of the surface runs from nearly white to dingy cream, to dark cream, pale umber, pale purple, or both tints in the same shell, pale ochre or sienna yellow, pale reddish brown to dark brown or light chocolate, with more or less bluish purple, etc., with various markings upon these ground tints. None of these tints or colors are what may be called brilliant; they are more vivid in the young shells, as well as in fresh or recently collected specimens.

I am not aware of any other species of *Tivela* that exhibits so many color varieties and markings, within so narrow a range of tints, as this. It requires a great number, however, and from many localities to fairly exhibit this variability. With a good series made with this intention a quite attractive result is attainable.

The series which forms the basis for this review, made by me expressly for the U. S. National Museum, includes selections from not less than a thousand specimens.

The first general segregation, the type aspect being in mind, is that ornamented with rays.

The greater proportion in any large promiscuous number are plain, but as a rayed example is the type of the species, the plain shells will have to be classed as varieties. The rayed ones may be grouped as follows:

GROUP I.

Dark rays on a light ground.

First, the typical, ground tints "cream." This must be expanded so as to include other ground tints, namely, dingy cream, dark cream slightly tinted with umber, sometimes very pale purplish; the anterior

angle darker, generally with numerous close set linear rays of purplish brown or brownish purple. The rays otherwise usually reddish brown dark or pale, narrow at the umbones and gradually widening toward the ventral margin. These rays may be few in number on one valve and numerous on the other; they often exhibit a somewhat serial arrangement; again in some individuals the rays on both valves may be few and narrow, linear; in other examples so numerous as to modify by obscuring the ordinary lighter ground tint.

The umbonal region is usually much lighter in these ("cream-color"); sometimes, rarely, the tip of the umbos is white or nearly white, and just below a tint of pale sienna-yellow.

The incremental growth is often marked by broad or narrow zones of purple.

The large adults seldom show the various color features or markings that are so often seen in shells one-third or one-half the maximum size.

The varietal segregation of such individuals as come within this group is no doubt somewhat arbitrary. Nevertheless, following after the type, we have certain facies that are reasonably separable when a large number of shells from different localities are compared, and the selections thus made by me for the U. S. National Museum series, whether the same may be regarded as worthy of varietal distinction or not, may be described as below:

The number of rays in the type, as figured in Reeve, is twenty, four of them being on the posterior slope; six of the rays are broad, the rest narrow, and three of the latter do not reach the beaks of the shell. This is in a general way a fair description of the average of the rayed individual.

The varieties following exhibit either very few, *many less* than the average or *very many more* rays than usual, giving at a glance a distinctive aspect to the examples included in these segregations.

Variety α , pauciradiata.

Light cream ground, rays reddish brown, few, linear, and usually narrow.

Variety β , multiradiata.

Ground tone very pale rufous, often slightly tinted with pale purple; rays reddish brown, numerous, linear, narrow; entire surface of valves closely rayed; rare.

Variety γ , alternata.

Ground color pale brownish or rufous, with more or less narrow rays irregularly alternating with broader rays; rays reddish brown.

Variety δ , eccentrica.

Ground and rays the same color as in the foregoing; the number of the rays on the two valves of the same shell conspicuously unlike; often

one valve will be panciradiate, the other multiradiate; again, in one valve the rays may be narrow and in the other marked with broad rays. Another aspect is seen with a few rays on one valve; on the other narrow and broad rays alternating, often with wide interspaces of the ground color.

Variety $\delta\delta$, serialis.

The foregoing variety might well be regarded as including this, though separated by me so as to include examples wherever the rays and ground color are of the same tints and shades, but the rays are arranged in a somewhat serial order, the two valves being unlike, however, as to the position of the rays and the number thereof.

These segregations δ and $\delta\delta$ will include nearly all that remain of the examples, inclusive, under the general head of Group I, that do not fall into the previous varietal sections.

Variety ϵ , interrupta.

This is an exceedingly rare aspect; only 1 in 500; the ground color dull white at the umbos, brownish or dark cream below, a few rays of pale rufous brown and these obsolete in the umbonal region and interrupted below.

Variety ζ , luteobrunnea.

Ground color yellowish brown in the umbonal region, warm dark, rufous, with purplish zones and tint below, and narrow and broad rays of pale purplish brown. A very rare variety; only 1 in 500.

GROUP II.

Light rays on a light ground.

Variety η , uniradiata.

In this variety, which is the commonest of the group, the ground color is usually the same as that of the type, though often somewhat darker, a pale umber or purplish ash, for instance, whichever may be the general tone of the surface; an anterior single paler ray extends from the umbo, gradually widening as it approaches the ventral margin; this ray closely adjoins and follows next to the anterior angle of the valves; otherwise this variety is usually plain, though occasionally marked with zones of pale purple or pale umber or a combination of these two tints.

Variety θ , biradiata.

This is a comparatively rare variety, with the ground tints the same as in the preceding. In addition to the anterior ray extending to the ventral edge of the valves, there is a short ray in the opposite direction. The umbonal region in this variety is usually pale ashen blue or faint dull reddish purple.

Variety ι , triradiata.

In this we find the characteristic ground tints of the two preceding varieties, with the dull purplish area in the region of the beaks, with an intermediate, rather broad central ray, which in some instances extends nearly or quite to the ventral margin, though usually terminating or fading into the general surface color at a point one-half or one-third of the distance from the beaks to the lower margin. This median ray is often composed of several narrow ones that interblend or coalesce. Common.

GROUP III.

Ground color warm buff, pale ochre, or sienna yellow.

Variety κ , ochracea.

In this group we have examples wherein the dominant tint of the surface is warmer than either of the foregoing varieties, a warm, rather dingy ochre or sienna yellow or pale yellowish brown, this color being more intense on the upper third or half of the valves, the lower part showing more or less purplish, with zones of the same of a little darker tint and the surface of the valves rather obscurely rayed with numerous linear markings. The anterior slope darker, purplish brown or brownish purple.

This variety leads the way to and connects the foregoing groups (I, II, and III) with the darker groups and varieties below.

GROUP IV.

In this group purple and brown tints prevail, sometimes chestnut and chocolate.

Variety λ , purpureo-chocolata.

Pale reddish brown to chocolate, with purplish tinge and conspicuous or inconspicuous concentric purple zones; frequently obscurely radiately lineated; anterior slope dark purple brown; umbonal region generally dark, though sometimes light; extreme tips of beaks usually dark purple, sometimes light.

GROUP V.

Here we find shells with the dark ground tones of the preceding, but ornamented with light rays.

Variety μ , biserialis.

This variety consists of examples with two white or light-colored rays extending from the beaks; these rays are usually short; ground color purplish brown or brownish-purple, with zones of pale purple

otherwise marked occasionally with faint interrupted linear rays. A rare form. The two-rayed examples in this Group, as well as in Group II, are quite rare.

Variety ν , triserialis.

Three white or light-colored rays; the middle one generally the most conspicuous, sometimes extending nearly to the ventral edges, often quite broad and formed by the coalescing of numerous narrow linear rays; the surface of the valves often exhibit faint lineation or suggestions of rays, also stipple-like markings. Extreme tips of umbos generally purple, though sometimes light.

Frequently the rays on both of the foregoing varieties are only slightly exhibited at the beaks.

Variety ξ , aurora.

Umbonal region whitish; this tint covers about one-third of the surface of the valves from the beaks, the edge of this whitish area closely linearly rayed, suggesting the flame-like radiations from the upper edge of the "northern lights;" the rest of the surface of the valves pale, dingy purplish brown, with zones of pale purple and pale brown. This is a variety of very rare occurrence.

GROUP VI.

This group includes individuals which exhibit two series of rays, dark and light, in the same shell.

Variety α , duplicata.

This is a very rare and pretty variety, in which the general tone of the ground is pale purplish brown, with somewhat darker zones. It differs from all of the other rayed varieties in this, that it has the dark rays of Group I and the light rays of Group V. The light rays are short in some instances; in others the middle light ray extends nearly to the ventral margin. I have found only seven examples in a thousand specimens. The dark rays vary in number; in one example these are as numerous as in Variety β , *multiradiata*.

In most of the foregoing there are subvarietal aspects readily perceived by the eye, but not so pronounced as to admit of a description that would enable one to determine them without a colored figure.

The color variation herein described is exceedingly local, the varieties mentioned under Group I excepted. Of these, *multiradiata* is apparently restricted to the Santa Monica region, as well as *luteobrunnea*.

Mr. Hemphill informed me that the only color variety occurring at San Diego and the region thereabout is *ochracea*, of Group III.

INTERIOR COLORATION.

Occasionally individuals are found in which the muscular scars are pale to dark chocolate, with a touch or tint of bluish purple. In a single example the whole of the inside of both valves was stained with bluish chocolate, the region of the muscular scars being darker than elsewhere. Ordinarily the inside of the valves is of a uniform whiteness, rarely showing a yellowish tinge.

VARIATION IN FORM.

From color variation we come to variation in form. As a whole, with a thousand or more examples under review, the form is found to be remarkably constant. The outline of a few extremes is herewith given.

The smallest, a junior (Plate XXIV, fig. 1), is unusually triangular and short; the only example in the large number I have compared. The next in size (Plate XXIV, fig. 4) is unusually elongated transversely, one of three.

The larger outline (Plate XXIV, fig. 2) is that of a specimen from the outer beach of Coronado Peninsula, San Diego, contained in the collection of Mr. Homer Hamlin, of Los Angeles. Here we find the anterior portion greatly produced, as will be seen by comparison with the middle outline (Plate XXIV, fig. 3), which is a fair representation of the ordinary run of specimens, which are nearly if not quite equilateral.

The large San Diego specimen is from a special habitat, indicating the deeper burrowing or holding on necessary in a rapid tideway, or on a shore where the water deepens quickly and is more or less turbulent. With the greater depth of immersion in the sea bed follows the necessity for greater length of siphons and increased length of shell by the building up or development of the valves in that portion for the protection of the soft parts, and we have here an illustration of the relation of the environment to form, as is also well shown in the large *Cardium* (*C. magnum*) of Florida, when examples from portions of the wave-washed Atlantic shore are compared with those from the quieter beaches on the Gulf side.

EXPLANATION OF PLATES.

PLATE XXIII.

Tivela crassatelloides Conrad.

Typical form, natural size. See page 371.

PLATE XXIV.

(All figures natural size.)

- Fig. 1. *Tivela crassatelloides* Conrad. Outline of an unusually short triangular example. See page 377.
2. Outline of a specimen from San Diego—much produced anteriorly. See page 377.
3. Outline of a typical example from Santa Monica, California. See page 377.
4. Outline of an unusually elongated specimen. See page 377.

PLATE XXV.

Fig. 1. *Tivela crassatelloides* Conrad.

A specimen from San Diego with the right valve and part of the right flap of the mantle removed to show the soft parts. The arrows show the direction of the siphonal current. The heart, perforated by the intestine, is seen above the gills. The anal end of the intestine is free in the atrium of the anal siphon. The distal margin of the branchial siphon is merely granular, of the anal siphon plain. The former is opaque white, the latter translucent white, both marked with black dots around the orifices. The foot is livid, the edge flesh color, bullate, and wrinkled, the sides vertically wrinkled and granulate. The gills flesh color, the heart orange, pulsating once every ten seconds. The adductor muscles are reddish, the mantle dark flesh color, with the edge pale waxen white and wrinkled. The body mass is livid flesh color, the palpi small, single, twisted, distally more or less bifid. The intestine is white externally. Drawn from life by Mr. William H. Dall; two-thirds natural size.

- 1a. Sketch of a curious translucent body, acting as a crop or gizzard, internally situated behind the oral orifice. The upper or transverse portion overhangs the lower like a lip and aliment enters the organ below it. This lip is continuous with the tubular part behind. The figure is of natural size. Drawn from life by Mr. William H. Dall. The specimen from which these figures were taken was collected at San Diego, California.